

## CLAIMS

1. A control device of a high-pressure fuel pump of an internal combustion engine having a fuel injection valve provided on a cylinder and the high-pressure fuel pump for pumping fuel to said fuel injection valve, characterized in that  
said high-pressure fuel pump comprises:  
a pressure chamber;  
a plunger for pressurizing the fuel in said pressure chamber;  
a fuel valve provided in said pressure chamber; and  
an actuator for operating said fuel valve, and characterized in  
that  
said control device has means for calculating a drive signal of  
said actuator so as to realize the variable discharge of said  
high-pressure fuel pump, and that means for calculating said drive  
signal has means for limiting end timing of the drive signal of said  
actuator to a predetermined phase.
2. The control device of a high-pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that means  
for limiting to said predetermined phase limits end timing of a drive  
signal of said actuator to be prior to top dead center of said plunger.
3. The control device of a high-pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that the  
means for limiting to said predetermined phase calculates the end  
timing of a drive signal of said actuator through the use of at least one  
of a number of revolutions of the engine, injection quantity from said  
fuel injection valve, battery voltage and coil resistance.

4. The control device of a high-pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that the means for limiting to said predetermined phase is an electronic circuit.

5. The control device of a high-pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that when the end timing of a drive signal of said actuator is limited to said predetermined phase, at least one of injection quantity from said fuel injection valve, fuel injection timing and ignition timing is changed and controlled.

6. A control device of a high-pressure fuel pump of an internal combustion engine having a fuel injection valve provided on a cylinder and a high-pressure fuel pump for pumping fuel to said fuel injection valve, characterized in that  
said high-pressure fuel pump comprises:  
a pressure chamber;  
a plunger for pressurizing the fuel in said pressure chamber;  
a fuel valve provided in said pressure chamber; and  
an actuator for operating said fuel valve, and characterized in  
that  
said control device has means for calculating a drive signal of  
said actuator so as to realize the variable discharge of said  
high-pressure fuel pump, and that means for calculating said drive  
signal has means for not outputting said drive signal when output  
timing of said drive signal of said actuator is a predetermined phase  
and thereafter.

7. The control device of a high-pressure fuel pump of an internal combustion engine according to Claim 6, characterized in that when said drive signal has not been outputted, at least one of injection quantity from said fuel injection valve, fuel injection timing, and ignition timing is changed and controlled.

8. A control device of a high-pressure fuel pump of a direct injection internal combustion engine having a fuel injection valve provided on a cylinder and a high-pressure fuel pump for pumping fuel to said fuel injection valve, characterized in that

    said high-pressure fuel pump comprises:

    a pressure chamber;

    a plunger for pressurizing the fuel in said pressure chamber;

    a fuel valve provided in said pressure chamber; and

    an actuator for operating said fuel valve, and characterized in

that

    said control device has means for calculating a drive signal of said actuator so as to realize the variable discharge of said high-pressure fuel pump, and that the means for calculating said drive signal has means for limiting the output timing of a drive signal of said actuator to be within a predetermined phase range.

9. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within said predetermined phase range limits output timing of a drive signal of said actuator to a point of time whereat we went back to the past from the bottom dead center of said plunger by a time period corresponding to said actuator operating time period, and thereafter.

10. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within said predetermined phase range limits the output timing of a drive signal of said actuator to be within a point of time whereat said plunger arrives at the top dead center.

11. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within said predetermined phase range limits the output timing of a drive signal of said actuator to be while said plunger arrives at the top dead center from the bottom dead center, and prior to the bottom dead center of said plunger and within an operating time period of said actuator.

12. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 1 to 11, characterized in that the means for calculating a drive signal of said actuator has means for operating a reference angle of said actuator on the basis of a basic angle of said actuator, target fuel pressure and actual fuel pressure, and means for correcting an working delay of the actuator, and calculates operation starting time of said actuator on the basis of these output signals.

13. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in that the means for limiting to be within said predetermined phase range limits an output signal from means for operating a reference angle of said actuator.

14. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in that the means for limiting to be within said predetermined phase range limits output signals from means for operating a reference angle of said actuator and means for correcting working delay of said actuator.

15. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 13 or 14, characterized in that the means for limiting to be within said predetermined phase range retrieves said phase range in response to an operating state of the internal combustion engine.

16. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 12 to 15, characterized in that the means for limiting to be within said predetermined phase range limits an amount of feedback control to be calculated from a difference between said actual fuel pressure and said target fuel pressure.

17. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 12 to 15, characterized in that the means for limiting to be within said predetermined phase range limits an amount of control for causing said actual fuel pressure to coincide with said target fuel pressure.

18. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 8 to

17, characterized in that the means for limiting to be within said predetermined phase range is an electronic circuit.

19. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 1 to 18, characterized in that means for calculating a drive signal of said actuator makes the width of the drive signal of said actuator variable by the number of revolutions of the internal combustion engine or/and the battery voltage.

20. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 1 to 19, characterized in that when said control device compares actual fuel pressure with target fuel pressure, the pressure difference exceeds a predetermined value, and continues for a predetermined time period or longer, the control device prohibits said high-pressure fuel pump from pressurizing.

21. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 1 to 20, characterized in that when said control device compares the actual fuel pressure with the target fuel pressure, the pressure difference exceeds a predetermined value and the actual fuel pressure is lower than the target fuel pressure, said control device causes said high-pressure fuel pump to discharge the whole.

22. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 1 to 21, characterized in that when said control device compares the actual

fuel pressure with the target fuel pressure, the pressure difference exceeds a predetermined value and the actual fuel pressure is higher than the target fuel pressure, said control device prohibits said high-pressure fuel pump from pressurizing.

23. The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to any of Claims 20 to 22, characterized in that said predetermined value or said predetermined time period is retrieved in response to an operating state of the internal combustion engine.